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ACCESSING ANOMALOUS STATES OF CONSCIOUSNESS WITH A BINAURAL BEAT TECHNOLOGY

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Abstract — Exposure to binaural beats in an environment of restricted stimulation coupled with a guidance process can safely provide access to and experiences in many propitious states of consciousness. This method requires a unique combination of well-understood psycho-physiological inductive techniques with the addition of a refined binaural-beat technology. Binaural beats provide potential consciousness-altering ***information*** to the brain's reticular activating system. The reticular activating system in turn interprets and reacts to this ***information*** by stimulating the thalamus and cortex thereby altering arousal states, attentional focus, and the level of awareness, i.e., the elements of consciousness itself. This effective binaural-beat process offers a wide variety of beneficial applications and vehicle for the exploration of expanded states of consciousness.

Keywords: consciousness – altered states

Introduction

The audio phenomenon known as binaural beating can be used to access altered states of consciousness. This is done through a process in which individuals in an environment of restricted stimulation willfully focus attentional processes on a combination of multiplexed audio binaural beats that are mixed with music, pink sound[1], and/or assorted natural sounds. In most cases the process also includes breathing exercises, guided relaxation, affirmation, and visualization. The binaural-beat element of the process appears to be associated with an electoencephalographic (EEG) frequency-following response in the brain.[2] Many studies have

[1] Pink sound is "white noise" (like the hiss sound from a television after a station has stopped transmitting) which has been equalized for human hearing. Lower-frequency components have been amplified and higher-frequency components reduced to create a more pleasing natural sound.

[2] A frequency-following response to a binaural beat has been demonstrated by Oster (1973) and in the context of hearing-acuity research (Hink et al., 1980).

demonstrated the presence of a frequency-following response to auditory stimuli, recorded at the vertex of the human brain (top of the head). This EEG activity was termed “frequency-following response” because its period (cycles per second) corresponds to the fundamental frequency of the stimulus (Smith, Marsh, & Brown 1975). Stated plainly, if the audio stimulus is 40 Hz the resulting measured EEG will show a 40 Hz frequency-following response using appropriate time-domain averaging protocols. Binaural-beat stimulation, coupled with the effects of the other procedures within the process outlined above, appears to regulate neuronal activity and encourage access to propitious mental states. The effectiveness of binaural beats in engendering state changes is supported by the consistent reports of thousands of users, as well as the documentation of physiological changes associated with its use.

The reported uses of this binaural-beat method for accessing propitious states of consciousness range from sensory integration (Morris 1990), relaxation, meditation, stress reduction, pain management, improved sleep (Wilson 1990; Rhodes 1993), health care (Carter 1993), and enriched learning environments and enhanced memory (Kennerly 1994) to creativity (Hiew 1995), enhanced intuition, remote viewing[3] (McMoneagle 1993), telepathy[4], and out-of-body experience.[5] An understanding of the applied binaural-beat technology involves the well-known autonomic effects of controlled breathing and progressive relaxation

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[3] Remote viewing is described as an ability to perceive locations remote in time or space by mental means alone. Remote viewers can describe and sketch locations and events beyond the range of the usual sensory input (cf.JSE, Vol. 10, No. 1 for several reports).

[4] Telepathy is commonly referred to as direct mind-to-mind communication without the aid of con- ventional external sensory input. Robert Monroe referred to this as nonverbal communication.

[5] The expressions “in” and “out-of-body” refer to individual awareness. In the out-of-body experience, mind-consciousness does not separate from the human tissue as in death. One’s mind is always experienced as being either in or out of the body. It depends on where awareness is focused. Being out-of- body simply means that there is no direct connection to certain material levels of consciousness, including the normally unconscious activities of breathing and heart function which continue without one’s attention. Being out-of-body is a consciousness experience with a shift of mind-consciousness and locale. Some enjoy this shift. Others become frightened that they may get lost and be unable to find their way back to their bodies. If one believes that the mind is in the brain, and one experiences what one believes is out-of-body awareness, it is easy to feel that one is too far from the “gas station” and that one can get stranded. But the mind is not the brain so there is no reason to fear. If one knows one is “out” one can always get back because there is some normally subconscious activity (respiration, heart beat, ***etc.)*** on the brain-material level to tether one back (Hunt, 1995).

and the psychology of affirmations and visualizations (subjects not addressed in this paper). For the purposes of this paper, discussion is limited to the physiology of the brain, the brain-mind model, brain waves and their relationship to the behavioral psychology of consciousness, and the role of the reticular activating system (RAS) in regulating brain waves and consciousness.

Binaural Beats and The Physiology of the Brain

Binaural beats were discovered in 1839 by a German experimenter, H. W. Dove. The human ability to "hear" binaural beats appears to be the result of evolutionary adaptation. Many evolved species can detect binaural beats because of their brain structure. The frequencies at which binaural beats can be detected change depending upon the size of the species' cranium. In the human, binaural beats can be detected when carrier tones[6] are below approximately 1000 Hz (Oster 1973). Below 1000 Hz the wave length of the signal is longer than the diameter of the human skull. Thus, signals below 1000 Hz curve around the skull by diffraction. The same effect can be observed with radio wave propagation. Lower-frequency (longer wave length) radio waves (such as AM radio) travel around the earth over and in between mountains and structures. Higher-frequency (shorter wave length) radio waves (such as FM radio, TV, and microwaves) travel in a straight line and cannot curve around the earth. Mountains and structures block these high-frequency signals. Because frequencies below 1000 Hz curve around the skull, incoming signals below 1000 Hz are heard by both ears. But due to the distance between the ears, the brain "hears" the inputs from the ears as out of phase with each other. As the sound wave passes around the skull, each ear gets a different portion of the wave. It is this phase difference that allows for accurate location of sounds below 1000 Hz.[7] Audio direction finding at higher frequencies is less accurate than it is for frequencies below 1000 Hz. At 8000 Hz the pinna (external ear) becomes effective as an aid to localization. Virtually all animal sounds are below 1000 Hz. It is easy to imagine why animals developed the ability to accurately detect the location of each others' sounds. The relevant issue here, however, is that it is this innate ability of the brain to detect a phase difference that enables it to perceive binaural beats.

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[6] Electronically produced binaural beats can be "heard" when audio tones of slightly different fre- quencies are presented one to each ear. These audio tones are referred to as carriers.

[7] In the case of signals above 1000 Hz the skull blocks the signal from the lee-side ear. The source of the sound 1s then determined by the brain to be in the general direction of the loud noise, there being a lower amplitude heard by the lee-side ear.

The sensation of “hearing” binaural beats occurs when two coherent sounds of nearly similar frequencies are presented, one to each ear, and the brain detects phase differences between these sounds. This phase difference normally provides directional information to the listener but when presented with stereo headphones or speakers the brain integrates the two signals, producing a sensation of a third sound called the binaural beat. Perceived as a fluctuating rhythm at the frequency of the difference between the two (stereo left and right) auditory inputs, binaural beats appear to originate in the brainstem’s superior olivary nucleus, the site of contralateral integration of auditory input (Oster 1973). This auditory sensation is neurologically routed to the reticular formation (Swann et al. 1982) and simultaneously volume conducted to the cortex where it can be objectively measured as a frequency-following response (Oster 1973; Smith, Marsh, & Brown 1975; Marsh, Brown & Smith 1975; Smith et al. 1978; Hink et al. 1980). The frequency-following response provides proof that the sensation of binaural beating has neurological efficacy.

Binaural beats can easily be heard at the low frequencies (< 30 Hz) that are characteristic of the EEG spectrum (Oster 1973; Atwater 1997). This perceptual phenomenon of binaural beating and the objective measurement of the frequency-following response (Oster 1973; Hink et al. 1980) suggest conditions which facilitate alteration of brain waves and states of consciousness. There have been numerous anecdotal reports and a growing number of research efforts reporting changes in consciousness associated with binaural-beats. Binaural beats in the delta (1 to 4 Hz) and theta (4 to 8 Hz) ranges have been associated with reports of relaxed, meditative, and creative states (Hiew 1995), sensory integration (Morris 1990), and used as an aid to falling asleep (Wilson 1990; Rhodes 1993). Exposure to audio-guidance training using lower-frequency binaural beats in concert with cognitive therapy resulted in decreased depressive symptoms in alcoholic patients (Waldkoetter & Sanders 1997). Binaural beats in the alpha frequencies (8 to 12 Hz) have increased alpha brain waves (Foster 1990) and binaural beats in the beta frequencies (typically 16 to 24 Hz) have been associated with reports of increased concentration or alertness (Monroe 1985), improved memory (Kennerly 1994), and increases in focused attention in mentally retarded adults (Guilfoyle & Carbone 1996).

Passively listening to binaural beats may not automatically engender an altered state of consciousness. The process usually used when listening to binaural beats includes a number of procedures; binaural beats are only one element. We all maintain a psychophysiological momentum, a homeostasis which may resist the influence of the binaural beats. These homeostatic states are generally controlled by life situations as well as by acts of will, both conscious and subconscious. The willingness and ability of the listener to relax and focus attention or their level of practice in meditative processes may in some way contribute to binaural-beat effectiveness. Naturally occurring neurological ultradian rhythms, characterized by periodic changes in arousal and states of consciousness (Webb & Dube 1981; Rossi 1986;

Shannahoff-Khalsa 1991), may underlie the anecdotal reports of fluctuations in the effectiveness of binaural beats. The perception of a binaural beat is said to be heightened by the addition of masking noise to the carrier signal (Oster 1973), so white or pink noise is often used as background. Practices such as humming, toning, breathing exercises, autogenic training, and/or biofeedback can also be used to interrupt the homeostasis of subjects resistant to the effects of binaural beats (Tart 1975).

Brain Waves and Consciousness

Controversies concerning the brain, mind, and consciousness have existed since the early Greek philosophers argued about the nature of the mind-body relationship, and none of these disputes has been resolved. Modern neurologists have located the mind in the brain and have said that consciousness is the result of electrochemical neurological activity. There are, however, growing observations challenging the completeness of these assertions. There is no neurophysiological research which conclusively shows that the higher levels of mind (intuition, insight, creativity, imagination, understanding, thought, reasoning, intent, decision, knowing, will, spirit, or soul) are located in brain tissue (Hunt 1995). A resolution to the controversies surrounding the higher mind and consciousness and the mind-body problem in general may need to involve an epistemological shift to include extra-rational ways of knowing (de Quincey 1994) and may well not be comprehended by neurochemical brain studies alone. Penfield (1975), an eminent contemporary neurophysiologist, found that the human mind continued to work in spite of the brain's reduced activity under anesthesia. Brain waves were nearly absent while the mind was just as active as in the waking state. The only difference was in the content of the conscious experience. Following Penfield's work, other researchers have reported awareness in comatose patients (Hunt 1995) and there is a growing body of evidence which suggests that reduced cortical arousal while maintaining conscious awareness is possible (Fischer 1971; West 1980; Delmonte 1984; Wallace 1986; Goleman 1988; Mavromatis 1991; Jevning, Wallace, & Beidenbach 1992). These states are variously referred to as meditative, trance, altered, hypnagogic, hypnotic, and twilight-learning states (Budzynski 1986). Broadly defined, the various forms of altered states rest on the maintenance of conscious awareness in a physiologically reduced state of arousal marked by parasympathetic dominance (Mavromatis 1991). Recent physiological studies of highly hypnotizable subjects and adept meditators indicate that maintaining awareness with reduced cortical arousal is indeed possible in selected individuals as a natural ability or as an acquired skill (Sabourin, Cutcomb, Crawford, & Pribram 1993). More and more scientists are expressing doubts about the neurologists' brain-mind model because it fails to answer so many questions about our ordinary experiences, as well as evading our mystical and spiritual ones. Studies in distant mental influence and mental healing also challenge the notion of a mind localized within the brain (Dossey 1994, 1996a). Nonlocal events have been proven to occur at the subatomic level and some researchers believe that the physics principles behind these events underlie nonlocal consciousness-

mediated effects (Dossey 1996a). Consciousness-associated anomalies appear unrestricted by spatial or temporal boundaries and many experiments have been done to shed light on this remarkable quality of the mind (Dossey 1996b). The scientific evidence supporting the phenomenon of remote viewing alone is sufficient to show that mind-consciousness is not a local phenomenon (McMoneagle 1993).

If mind-consciousness is not the brain, why then does science relate states of consciousness and mental functioning to brain-wave frequencies? There is no objective way to measure mind or consciousness with an instrument. Mind-consciousness appears to be a field phenomenon which interfaces with the body and the neurological structures of the brain (Hunt 1995). One cannot measure this field directly with current instrumentation. On the other hand, the electrical potentials of the body can be measured and easily quantified. The problem here lies in oversimplification of the observations. EEG patterns measured on the cortex are the result of electroneurological activity of the brain. But the brain's electroneurological activity is not mind-consciousness. EEG measurements then are only an indirect means of assessing the mind-consciousness interface with the neurological structures of the brain. As crude as this may seem, the EEG has been a reliable way for researchers to estimate states of consciousness based on the relative proportions of EEG frequencies. Stated another way, certain EEG patterns have been historically associated with specific states of consciousness. Although not an absolute, it is reasonable to assume, given the current EEG literature, that if a specific EEG pattern emerges it is probably accompanied by a particular state of consciousness.

Binaural beats can alter the electrochemical environment of the brain allowing mind-consciousness to have different experiences. When brain waves move to lower frequencies and awareness is maintained, a unique state of consciousness emerges. Practitioners of the binaural-beat process call this state of hypnagogia "mind awake/body asleep." Slightly higher-frequencies can lead to hyper-suggestive states of consciousness. Still higher-frequency EEG states are associated with alert and focused mental activity needed for the optimal performance of many tasks.

Perceived reality changes depending on the state of consciousness of the perceiver (Tart 1975). Some states of consciousness provide limited views of reality, while others provide an expanded awareness of reality. For the most part, states of consciousness change in response to the ever-changing internal environment and surrounding stimulation. For example, states of consciousness are subject to influences like drugs and circadian and ultradian rhythms (Webb & Dube 1981; Rossi 1986; Shannahoff-Khalsa 1991). Specific states of consciousness can also be learned as adaptive behaviors to demanding circumstances (Green & Green 1986). Binaural-beat technology offers access to a wide variety of altered-state experiences for those wanting to explore the realms of consciousness.

Hemispheric Synchronization

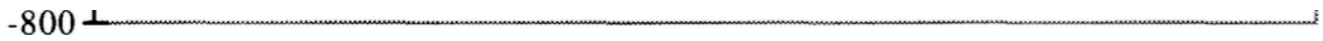
Many of the states of consciousness available through this technology have been identified as presenting unique hemispherically synchronized brain-wave frequencies. Although synchronized brain waves have long been associated with meditative and hypnagogic states, the binaural-beat process may be unique in its ability to induce and improve such states of consciousness. The reason for this is physiological. Each ear is “hardwired” (so to speak) to both hemispheres of the brain (Rosenzweig 1961). Each hemisphere has its own olivary nucleus (sound-processing center) which receives signals from each ear. In keeping with this physiological structure, when a binaural beat is perceived there are actually two electrochemical synaptic waves of equal amplitude and frequency present, one in each hemisphere. This is, in and of itself, hemispheric synchrony of synaptic activity. Binaural beats appear to contribute to the hemispheric synchronization evidenced in meditative and hypnagogic states of consciousness. Binaural beats may also enhance brain function by enabling the user to mediate cross-collosal connectivity at designated brain-wave frequencies.

The two cerebral hemispheres of the brain are like two separate information processing modules. Both are complex cognitive systems; both process information independently and in parallel; and their interaction is neither arbitrary nor continuous (Zaidel 1985). Because of this, states of consciousness (mind-consciousness interfacing with the brain) can be defined not only in terms of brain-wave frequency ratios, but also in terms of hemispheric specialization and/or interaction. Some desired states of consciousness may require facile inter-hemispheric integration, while others may call for a unique hemispheric processing style. An individual’s cognitive repertoire and, therefore, his ability to perceive reality and deal with the everyday world, is subject to his ability to experience various states of consciousness (Tart 1975). Binaural beats provide the tools for individuals to expand their ability to experience a wide range of mind-consciousness states.

Each state of consciousness is not represented by one simple brain wave but involves a milieu of inner-mixing wave forms, a field effect. The reason for this lies in the structure of the brain itself. Not only is the brain divided horizontally into hemispheres, it is also divided vertically from the brainstem to the cerebellum, the thalamus, the limbic system, and the cerebral cortex. The cerebral cortex is further divided into such functional areas as the frontal lobes, the parietal lobes, the temporal lobes, and the occipital lobes. There are, of course, many other subdivisions of the brain which have not been mentioned. The critical point is that for each discrete state of consciousness, mind-consciousness interfaces with each area of the brain and each area resonates at a specific brain-wave frequency unique to that interface because it performs a localized function (Luria 1970).

Developing Effective Binaural Beat

The process of developing effective stimuli relied initially on the feedback of those experiencing altered states while listening to binaural beats (Atwater 1997), and more recently with the aid of EEG technology. Originally, researchers tested many subjects under laboratory conditions for their responses to binaural-beat stimuli. Records were kept as to the effect each binaural-beat frequency had on these subjects. Then binaural beats were mixed and records were again kept on the subjects' responses. After months (in some cases, years), test results began to show population-wide similar responses to specific mixes of binaural beats. Certain complex, brain-wave-like combinations of binaural beats were reported more effective than other combinations, and more effective than binaural beats of single frequencies (sine waves). Effective binaural beats are, therefore, unique in that they are designed to be complex brain-wave-like patterns rather than simple sine waves. (See illustrations below.)



2 Seconds
Fig. 1 Complex Binaural Beat

2 Seconds
Fig. 2 Sine Wave Binaural Beat

How Binaural Beats Alter States of Consciousness

Two decades ago it was assumed that the mechanism behind the consciousness-altering effects of binaural beats was some how related to entrainment of the auditory frequency-following response – a theorized process of nonlinear stochastic resonance of brain waves with the frequency of the auditory stimulus. Since an auditory frequency-following response could be measured at the cortex it seemed logical to assume that the underlying consciousness-altering mechanism must be some form of Newtonian entrainment process at work. Continuing research revealed, however, that there is no effect-mechanism to support the notion that entrainment of the auditory frequency-following response could occur or is responsible for alterations in consciousness. Comparisons to photic entrainment models are not supported because the EEG signal strength of the measured auditory frequency-following response of binaural beats is too low. At this point it is hard to even speculate that the neural activity of the frequency-following response could, in some electromagnetically inductive way, alter ongoing brain-wave activity.

A review of the appropriate literature reveals that brain waves and related states of consciousness are said to be regulated by the brain's reticular formation stimulating the thalamus and cortex. The extended reticular-thalamic activation system (ERTAS) is implicated in a variety of functions associated with consciousness (Newman 1997). The word reticular means "net-like" and the neural reticular formation itself is a large, net-like diffuse area of the brainstem (Anch et al. 1988). The reticular activating system (RAS) interprets and reacts to information from internal stimuli, feelings, attitudes, and beliefs as well as external sensory stimuli by regulating arousal states, attentional focus, and the level of awareness – the elements of consciousness itself (Empson 1986; Tice & Steinberg 1989). How we interpret, respond, and react to information then, is managed by the brain's reticular formation stimulating the thalamus and cortex, and controlling attentiveness and level of arousal (Empson 1986). "It would seem that the basic mechanisms underlying consciousness are closely bound up with the brainstem reticular system . . ." (Henry 1992).

In order to alter consciousness it is necessary to provide some sort of information input to the RAS. Binaural beats appear to influence consciousness by providing this *information*. The *information* referred to here includes the character, quality, and traits of the state of consciousness of the complex, brain-wave-like pattern of the binaural beat (see previous illustration). These unique binaural-beat wave forms (neurologically evidenced by the EEG frequency-following response) are recognized by the RAS as brain-wave pattern information. If internal stimuli, feelings, attitudes, beliefs, and external sensory stimuli are not in conflict with this information (e.g., an internal, even unconscious, fear may be a source of conflict), the RAS will alter the state of consciousness as a natural function of maintaining homeostasis[8] by regulating brain activity to synthesize the integrated binaural-beat stimulus (sensing it as a component of ongoing neural activity).

Without conflict, the RAS initiates replication of the character, quality, and traits of the neurologically evident and persistent binaural beating. As time passes, the RAS monitors both the internal and external environment and the state of consciousness itself (in terms of neural activity) to determine, from moment to moment, its suitability for dealing with existing conditions. As long as no conflicts develop, the RAS naturally continues aligning the listener's

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[8] The brain automatically and actively regulates all body functions to maintain homeostasis - an internal equilibrium (Green & Green, 1977; Swann ***et*** al., 1982). In a nathral and constant attempt to maintain a homeostasis of the elements of consciousness, the RAS actively monitors and continues the neural replicat~onof ongoing brain-wave states (unless, of course, there is reason to make an adjustment due to new information from internal sources or external sensory input).

state of consciousness with the information in the brain-wave-like pattern of the binaural sound field.

In objective, measurable terms EEG-based research provides evidence of binaural beat's influence on consciousness. Since the RAS regulates cortical EEG (Swann et al. 1982), monitoring EEG chronicles performance of the RAS. There have been several free-running EEG studies (Foster 1990; Sadigh 1990; Hiew 1995, among others) which suggest that binaural beating induces alterations in EEG. Because the RAS is responsible for regulating EEG (Swann et al. 1982; Empson 1986), these studies document measurable changes in RAS function during exposure to binaural beats.

It is tempting to speculate about a neurophysiological model underlying a binaural-beat-engendered state of consciousness labeled mind awake/body asleep, a hypnagogic experience common to many. In this state, a greater proportion of lower frequency brain waves (theta and delta) have been recorded in the EEG. The "body asleep" part of this state may be tied to the increase in delta waves associated with hyper-polarization of thalamocortical cells (Steriade, McCormick, & Sejnowski 1993). The "mind awake" part of this state may be associated with theta frequencies in a portion of the hippo-campus. One is said to have achieved this state of mind-consciousness when a new condition of hypnagogic homeostasis is established and one becomes oblivious to the location of body extremities (hands, feet, etc.), still without losing consciousness (falling asleep).

Summary

The binaural-beat auditory-guidance process provides access to many beneficial mind-consciousness states. This process is a unique combination of well-understood psycho-physiological inductive techniques (restricted environmental stimulation, controlled breathing, progressive relaxation, affirmation, visualization, etc.) with the addition of a refined binaural-beat technology providing potential consciousness-altering information to the brain's reticular activating system. This safe and effective binaural-beat process offers a wide variety of applications which include, but are not limited to: relaxation, meditation, enhanced creativity, intuition development, enriched learning, improved sleep, wellness, and the exploration of expanded mind-consciousness states.

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